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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B32B 15/00	A1	(11) International Publication Number: WO 98/07565 (43) International Publication Date: 26 February 1998 (26.02.98)

(21) International Application Number: PCT/US97/14769

(22) International Filing Date: 22 August 1997 (22.08.97)

(30) Priority Data:
60/024,309 23 August 1996 (23.08.96) US

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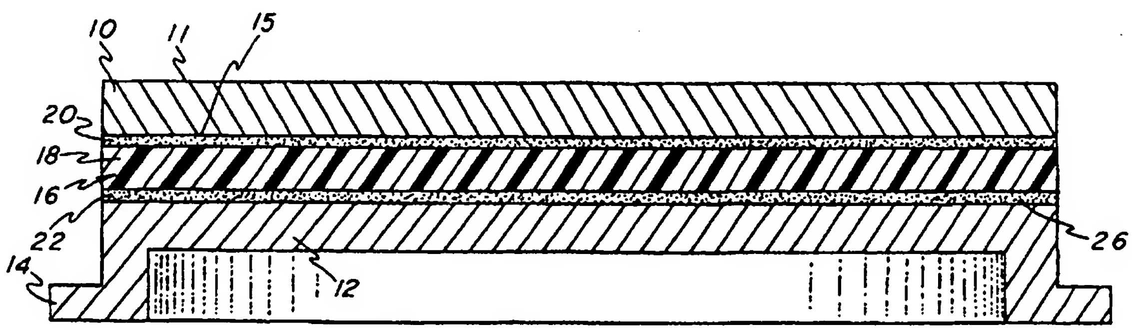
(81) Designated States: JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: BONDING WITH A CONDUCTIVE ADHESIVE SHEET MATERIAL



(57) Abstract

A method of bonding sputter targets (10) to backing plate members (12) using electrically conductive double-sided adhesive sheet material (16) such as a tape. The conductive sheet material (16) is applied to either the sputter target (10) or the backing plate (12). The target (10) is then positioned over, and pressed onto, the backing plate surface (26), thereby forming a bond between the target (10) and the backing plate (12). Pressure may be applied to the bonded interface for an extended time to improve bond integrity. Target/backing plate assemblies (10, 12) bonded by the method, as well as a method for separating and replacing the target (10), are also disclosed.

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BONDING WITH A CONDUCTIVE ADHESIVE SHEET MATERIAL

Field of the Invention

The present invention relates to methods of bonding sputter targets to associated backing plate members and to the so-bonded target/backing plate assemblies. More particularly, the invention pertains to methods and assemblies wherein the sputter target is bonded to its associated backing plate member using a conductive adhesive sheet material.

Background of the Invention

Cathodic sputtering is widely used for the deposition of thin layers of material onto desired substrates. Basically, this process requires a gas ion bombardment of a target having a face formed of a desired material that is to be deposited as a thin film or layer on a substrate. Ion bombardment of the target not only causes atoms or molecules of the target material to be sputtered but also imparts considerable thermal energy to the target. Typically, this heat is dissipated by use of a cooling fluid circulated beneath or around a backing plate that is positioned in heat exchange relation with the target.

The target forms a part of a cathode assembly which together with an anode is placed in an evacuated chamber that contains an inert gas, preferably argon. A high voltage electrical field is applied across the cathode and anode. The inert gas is ionized by collision with the electrons ejected from the cathode. Positively charged gas ions are attracted to the cathode and, upon impingement with the target surface, dislodge the target material. The dislodged target materials traverse the evacuated enclosure and deposit as a thin film on the desired substrate that is normally located proximate to the anode.

In order to achieve good thermal and electrical conductivity between the target and the backing plate, these members are commonly attached to each other by the use of soldering or brazing. In this prior art process, a layer of low-melting point metal is used at the target-backing plate interface to effectively join the two,

often dissimilar, materials. Various target and backing plate material combinations require the appropriate selection of solder alloy, surface preparation techniques, and joining conditions in order to assure the proper formation of an integral metallurgical bond. Typically the surface of both the target and backing plate must be "wetted" by the solder alloy to allow for a localized metallurgical reaction responsible for bond integrity.

However, many metallic and most non-metallic materials are not readily "wetted" by the solder alloys due to the presence of chemically stable films on their surfaces. These surface films, which are generally oxide in nature, must be eliminated or replaced with more reactive layers in order to promote good adhesion after bonding. Well-known techniques, including fluxes, mechanical abrasion, application of ultrasonic energy, and the addition of a preplated "electrolytic or sputtered" surface layer of a metal more favorably disposed to bonding, have been used to promote good bonding adhesion as well as to expand the number of material combinations that may be bonded using a solder or braze technique. However, these processes are generally complex, expensive, and often not well suited to large scale production.

Another drawback to the use of solder alloys to secure targets to backing plates is that used targets cannot be readily separated from the backing plates for replacement. During the sputtering process, the target is consumed while the backing plate typically remains substantially intact. Reuse of the backing plate with a new target would significantly reduce the cost of repetitive sputtering operations.

Alternatively, conductive epoxies have been used to bond sputtering targets to backing plates. However, conductive epoxies are generally difficult to apply and usually require extended curing times at elevated temperatures while under vacuum. Moreover, many epoxies outgas or emit unacceptably high levels of contaminants that can interfere with the sputtering process.

Accordingly, there remains a need for an inexpensive, simple and effective bonding method that is capable of providing a durable bond exhibiting excellent electrical conductivity while maintaining acceptable thermal conductivity.

There remains an even more specific need for the provision of a

bonding method that may be employed to bond a large number of material combinations without the necessity of time consuming and complex material preparation procedures.

Summary of the Invention

The present invention provides a method for bonding sputtering targets to backing plate members using conductive double-sided adhesive sheet materials such as tape.

In the proposed bonding method, a commercially available conductive adhesive sheet material such as a tape having a pressure-sensitive-adhesive (PSA) on both upper and lower surfaces is utilized. The conductive sheet is cut or otherwise formed into the desired geometric shape to cover the target/backing interfacial area and is then applied to either the sputter target or backing plate. The target is then positioned over, and pressed onto, the backing plate surface, thereby forming a bond between the target and backing plate. Pressure may be applied to the bonded interface for an extended time to improve bond integrity.

The method of the invention creates a permanent bond between the sputter target and the backing plate which is both electrically and thermally conductive. No heating is required to bond the pressure-sensitive adhesive to the sputter target and to the backing plate. The conductive double-sided adhesive sheet is less expensive than solder alloys and requires no skilled labor to apply.

The method is particularly useful for bonding ceramic sputter targets to metallic backing plates. Sputter targets formed from ceramic materials such as indium-tin-oxide and nickel oxide which are difficult to "wet" with solder alloys bond readily with the conductive double-sided adhesive sheets after minimal surface preparation.

In addition, the invention provides a method for separating and replacing used sputter targets secured to backing plates with conductive sheet materials. A solvent such as ethanol is introduced between the used sputter target and the backing plate to at least partially dissolve the adhesive on the conductive adhesive sheet. The used sputter target is then separated from the backing plate. A

new sputter target is secured to the backing plate with a new conductive adhesive sheet.

Therefore, it is one object of the invention to provide simple and inexpensive target assembly structures and methods providing durable conductive bonds between a variety of sputter target and backing plate materials. The invention will be further described in conjunction with the appended drawings and the following detailed description.

Detailed Description of the Drawings

Fig. 1 is a transverse cross-sectional view of a bonded target-backing plate assembly in accordance with the invention; and

Fig. 2 is a transverse cross-sectional view of a replacement target-conductive adhesive sheet combination in accordance with the invention.

Detailed Description of the Preferred Embodiment

Turning now to Fig. 1 of the drawings, there is shown a conductive adhesive sheet bonded target-backing plate assembly in accordance with the present invention. Target 10 is superposed atop heat conductive backing plate 12. The target comprises a face 11 from which material will be ejected during the sputtering process and a bottom or bonding side 15 adjacent the backing plate 12. As shown, a peripheral flange 14 integral with backing plate 12 serves to mount the assembly as a cathode in an evacuated sputter coating chamber in accordance with well-known techniques.

A conductive sheet material 16 is provided for bonding the bottom surface 15 of the target 10 to the top surface 26 of the backing plate 12. The sheet material 16 includes a substrate layer 18, which preferably comprises a matrix impregnated with electroconductive species throughout. Examples of such electroconductive species include carbonaceous particles, metal powder or flakes, or conductive ceramic particles.

Among the carbonaceous materials which have found use in conductive substrates are carbon black and graphite particles. At present it is

preferred to use carbon black particles as the electroconductive species in the substrate layer 18.

Other electroconductive materials for use in the substrate layer 18 include particles or flakes of metals such as nickel, copper, gold and silver flakes, as well as particles of ceramics such titanium nitride and titanium carbide.

The matrix itself may be composed of electroconductive materials such as a graphite mesh or the like. Alternatively, the matrix may be composed of a porous fabric-like matrix composed, for example, of glass or polymeric materials may be used.

Techniques for impregnating the electroconductive species in the matrix include dispersing the electroconductive species in a resin dispersant medium such as, for example, water soluble resins, or water dispersable anionic or cationic resins in latex form. Such resin dispersant media include well known resins such as urethane resins, acrylic resins, polyester resins, polybutadiene resins and other synthetic resins.

The substrate 18 is interposed between upper and lower adhesive layers 20, 22. The adhesive layers 20, 22 may be formed from any suitable pressure-sensitive-adhesive (PSA), as is well known in the art. Desirably, the PSA is itself an electroconductive PSA. A discussion of exemplary electrically conductive PSA's and formulations thereof may be found in U.S. Pat. No. 5,082,595, herein incorporated by reference. Additionally conductive adhesives are discussed in detail in the "Handbook of Adhesives", Third Edition, Skeist, 1990, pages 705-712.

The conductive sheet 16 of the preferred embodiment of the present invention is double-sided, electrically conductive, adhesive carbon tape, Part #AR-8001 available from Adhesives Research, Inc. (Glen Rock, PA), or alternatively, double-sided, electrically conductive, adhesive carbon sheets, Part #STR-9180 available from Shinto Chemitron Co., Ltd. (Tokyo, JP). Preferably, the conductive sheet 16 has a thickness no greater than approximately 0.25mm, and, even more preferably, on the order of approximately 0.13mm.

In preparation for bonding, it is preferred that the surfaces to be joined are cleaned using a solvent wipe or similar means wherein surface contamination in

the form of particulates or oil films is removed. The conductive sheet 16 is die cut or otherwise formed into a desired size and shape to closely match the size and shape of the target/backing plate interface.

The conductive sheet 16 is then applied to either the target 10 or the backing plate 12. Preferably, the conductive sheet 16 is applied the bottom surface 15 of the target 10 first, though the conductive sheet 16 may be applied first to the top surface 26 of the backing plate member 12.

Preferably, the conductive sheet 16 is die cut to a size and shape slightly smaller than the bottom surface 15 of the target 10 and the top surface 26 of the backing plate 12. Then, even if the conductive sheet 16 is misaligned slightly on the bottom surface 15 of the target 10 or the top surface 26 of the backing plate 12, no portion of the conductive sheet 16 will protrude beyond the sides of the target 10 and the backing plate 12. This minimizes the need to trim away a portion of the conductive sheet 16 after the bond is formed and helps to hide the conductive sheet 16 from the final user.

The target 10 is then positioned over, and pressed onto, the backing plate 12 so that the lower surface 22 of the conductive sheet 16 contacts the top surface 26 of the backing plate 12 and the upper surface 20 of the conductive sheet 16 contacts the bottom surface 15 of the target 10. Appropriate fixtures may be used to align the sputter target 10 with the backing plate 12. Although at this point the bonding operation is considered complete, pressure may be applied to the bonded system for an extended period of time after the initial joining to improve bond integrity. No heating is required; the target 10 and backing plate 12 preferably remain at ambient temperature through the process.

The bonding process described above is advantageously applied to the bonding of ceramic sputter targets 10 to metallic backing plates 12. The bottom surfaces 15 of sputter targets 10 comprising ceramic materials such as carbon, indium-tin-oxide, nickel oxide, germanium oxide, indium oxide and silicon oxide often require costly preparation before bonding with solder alloys. The facing surfaces 26 of backing plates 12 comprising metals such as copper, copper alloys, aluminum and aluminum alloys often require preparation as well prior to bonding

with solder alloys compatible with the sputter targets 10.

Favorable results have been obtained from the use of conductive sheets 16 to bond ceramic sputter targets 10 to metallic backing plates 12. Target assemblies comprising indium-tin-oxide sputter targets bonded to copper backing plates with die-cut, double-sided, electrically conductive adhesive carbon sheets, Part #STR-9180 available from Shinto Chemitron (Tokyo, Japan), have been used satisfactorily in low power CONMAG sputtering systems. In addition, nickel oxide sputtering targets have been successfully bonded to copper backing plates using die-cut, double-sided electrically conductive adhesive carbon sheets. While carbon sputter targets have not yet been satisfactorily bonded to aluminum backing plates using conductive sheets, it is believed that successful bonds will be obtained by this method in the future.

The bond resulting from the present invention is flexible while providing excellent bonding strength. The interface between the target 10 and backing plate 12 is viscous, allowing for a compliant layer at the interface which helps alleviate stresses resulting from thermal expansion due to heating during the sputtering process. This resulting flexibility is advantageous when bonding materials having dissimilar thermal expansivities, such as metals and non-metals, thereby allowing for the selection of a target 10 and backing plate 12 from a wide range of available materials.

The bonding process described above yields significant cost savings compared to processes involving soldering or brazing. Labor costs are reduced since no skilled labor is required.

The process minimizes the need for extensive surface preparation other than cleaning or wiping of the facing surfaces 15, 26 of the sputter target 10 and the backing plate 12. The conductive sheet 16 may be applied directly to a saw-cut backing plate surface, thereby eliminating the need for costly machine finishing. In fact, the roughness of a saw-cut surface enhances bond integrity. Nonetheless, conventional surface preparations, such as the deposition of a nickel anchoring layer on a copper backing plate, may improve the adhesion of the conductive sheet 16 to certain metal or ceramic materials.

Yet another advantage of the process described above is the ease of separating and replacing a used sputter target 10 secured to a backing plate 12 by conductive sheet material 16. In order to separate the used sputter target 10 from the backing plate 12, a solvent such as ethanol is introduced between the sputter target 10 and the backing plate 12 to at least partially dissolve the adhesive 20, 22 on the conductive sheet material 16. According to one embodiment, the sides of the sputter target 10 and the backing plate 12 are wiped with a sheet material (not shown) impregnated with the solvent so as to force the solvent between the sputter target 10 and the backing plate 12.

Once the bond securing the used sputter target 10 to the backing plate 12 is weakened by the solvent, the target 10 and the backing plate 12 are pulled apart. Once the two are separated, the surface 26 of the backing plate 12 is wiped with the sheet material (not shown) impregnated with the solvent, as necessary, to remove the used conductive sheet material 16 and any residual adhesive from the surface 26.

Once the used sputter target is separated from the backing plate 12, a replacement sputter target is bonded to the surface 26 of the backing plate 12 with a replacement conductive sheet. The replacement sputter target and the replacement conductive sheet are provided either separately or as a unit.

Referring to Fig. 2, a preferred sputter target/conductive sheet combination or intermediate for use in the replacement of used sputter targets 10 (Fig. 1) includes a replacement sputter target 10′ and a replacement conductive sheet 16′. The replacement conductive sheet 16′, which is preferably of the same structure as the conductive sheet 16 (Fig. 1), includes a conductive substrate 18′ positioned between two adhesive layers 20′ and 22′. The adhesive layer 20′ bonds the replacement conductive sheet 16′ to the bottom surface 15′ of the replacement sputter target 10′. Prior to use, a release liner 28′ covers the adhesive layer 22′.

When it is desired to bond the replacement sputter target 10′ to a backing plate 12, the release liner 28′ is stripped off the adhesive layer 22′. The replacement sputter target 10′ is then positioned over, and pressed onto, the backing plate 12 so that the adhesive layer 22′ contacts the top surface 26 of the backing plate

12. Further pressure is applied to the replacement sputter target 10′ and the backing plate 12 as needed to improve bond integrity.

The preceding description and accompanying drawing are intended to be illustrative of the invention and not limiting. For example, and not by way of limitation, a freestanding conductive adhesive layer may be substituted for the conductive sheet 16 of Fig. 1. Various other modifications and applications will be apparent to one skilled in the art without departing from the true spirit and scope of the invention as defined by the following claims.

--Claims--

1. Method of adhesive bonding a sputter target to a backing plate member comprising the steps of:

a) providing a conductive sheet material including first and second surfaces covered with an adhesive;

b) providing a sputter target including a first contact surface;

c) providing a backing plate member including a second contact surface, said second contact surface facing said first contact surface;

d) applying said conductive sheet material to one of said first contact surface and said second contact surface;

e) pressing the other of said first contact surface and said second contact surface into contact with said conductive sheet.

2. A method as recited in claim 1, wherein said conductive sheet material includes a carbon substrate layer.

3. A method as recited in claim 1, further comprising the step of cleaning said first contact surface and said second contact surface prior to applying said conductive sheet material.

4. A method as recited in claim 1, further comprising the step of die cutting said conductive sheet material prior to applying said conductive sheet material.

5. A method as recited in claim 1, further comprising the step of applying continued pressure to said sputter target and said backing plate member to effect bonding with said conductive sheet material.

6. A method as recited in claim 1 wherein said step b) includes providing a ceramic sputter target, and wherein said step c) includes providing a metallic backing plate member.

7. A method as recited in claim 1 wherein said step b) includes providing a ceramic sputter target composed at least in part of a material selected from the group consisting of indium-tin-oxide and nickel oxide, and wherein said step c) includes providing a metallic backing plate member composed at least in part of copper.

8. A method as recited in claim 1 wherein said sputter target and said backing plate are at ambient temperature throughout the method.

9. Target assembly made by the method of claim 1.

10. Combination comprising:

a) a sputter target having a face surface from which material will be ejected during a sputtering process and a bottom surface;

b) a backing plate;

c) a conductive sheet material interposed between and bonding said bottom surface of said target and said backing plate.

11. Combination as recited in claim 10 wherein said conductive sheet material comprises a matrix having opposed first and second surface areas and pressure sensitive adhesive layers positioned adjacent said first and second surface areas.

12. Combination as recited in claim 11 wherein said conductive sheet material is in the form of a tape.

13. A method for replacing a first sputter target with a second sputter target in a target assembly wherein a first conductive sheet including at least one adhesive layer bonds the first sputter target to a backing plate member, the method comprising the steps of:

a) introducing a solvent between the first sputter target and the backing plate member, the solvent being effective to at least partially dissolve the adhesive layer;

b) separating the first sputter target and the first conductive sheet from the backing plate member; and

c) bonding the second sputter target to the backing plate member with a second conductive sheet.

14. An intermediate for use in constructing a target assembly, said intermediate comprising:

a) a sputter target defining a sputter target bottom surface;

b) a conductive sheet including a conductive substrate positioned between a first adhesive layer and a second adhesive layer, said first adhesive layer bonding said conductive substrate to said sputter target bottom surface; and

c) a release liner releasably bonded to said second adhesive layer.

15. An intermediate as recited in claim 14 wherein said conductive substrate is composed at least in part of polymer.

16. An intermediate as recited in claim 14 wherein said first and second adhesive layers are electrically conductive adhesive layers.

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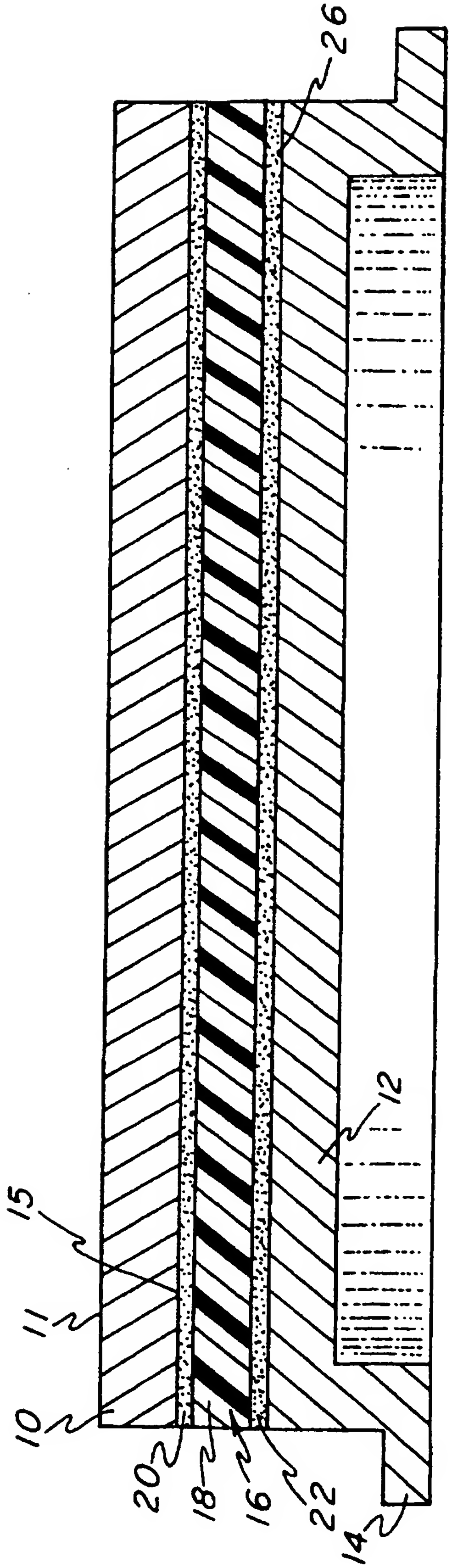

FIG-1

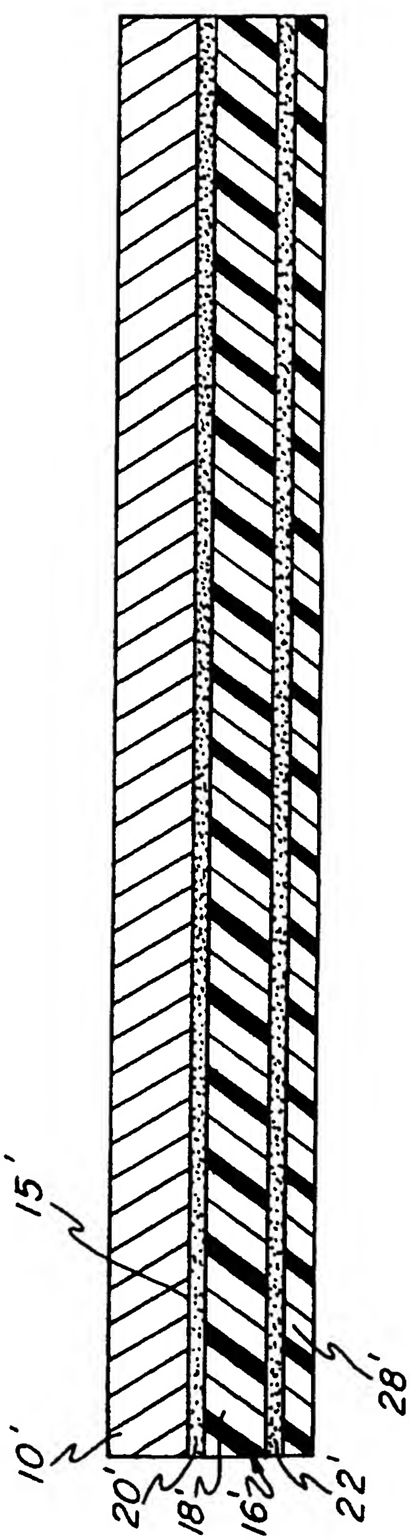

FIG-2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/14769

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :B32B 15/00
US CL :204/298.12, 298.13; 156/152, 247, 306.6; 428/323, 354, 356
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 204/298.12, 298.13, 298.15; 156/152, 247, 299, 306.6; 428/323, 328, 344, 354, 356

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,522,535 A (IVANOV et al) 4 June 1996, Abstract.	1-16
Y	US 5,213,868 A (LIBERTY et al) 25 MAY 1993, Abstract, col. 5, lines 1-6 and 59-63.	1-16
Y	US 5,181,671 A (MIZUNO) 26 January 1993, Abstract.	13
Y	US 5,116,676 A (WINSLOW) 26 May 1992, Abstract.	13
A	US 5,082,595 A (GLACKIN) 21 January 1992, Abstract.	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"O"	document referring to an oral disclosure, use, exhibition or other means		
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